Appendix M

Effects of Flow-Related Covered Activities on Lake Mead

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M.1 Introduction

This appendix documents the effects of the covered actions on the elevation of Lake Mead. The U.S. Department of the Interior, Bureau of Reclamation (Reclamation) has identified three future flow-related actions that may affect elevations at Lake Mead. These potential future actions are: 1) the extension of surplus criteria; 2) the adoption of shortage criteria; and, 3) transfers within the Lower Basin. The purpose of this analysis is to determine whether the anticipated changes in lake elevations are likely to have effects on riparian or fish habitat. The impact analysis contained in this appendix looks at the combined affects of all three types of actions. An analysis was also performed to determine the effects of each individual action, which are presented in detail.

Reclamation has described conservation measures in the *Biological Opinion for Interim Surplus Criteria, Secretarial Implementation Agreements, and Conservation Measures on the Lower Colorado River, Lake Mead to the Southerly International Boundary Arizona, California and Nevada* (ISC/SIA BO) (U.S. Fish and Wildlife Service 2001). The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) model of effects to Lake Mead includes an assumption that the Interim Surplus Criteria (ISC) continue through 2051. This model assumption has been carried through in the LCR MSCP analysis to estimate the most permissive potential set of surplus criteria and therefore a “worse-case” scenario of potential effects.

M.2 Continuation of Ongoing Conservation Measures

The conservation measures described in the ISC/SIA BO are designed to reduce the significance of effects on listed species and critical habitat. Although the analysis of impacts on Lake Mead does not indicate significant new effects resulting from the covered actions, continuation of the measures described in the ISC/SIA BO as described below are to be included in the LCR MSCP.

1. LCR MSCP will continue to provide funding and support for continuation of the ongoing Lake Mead razorback sucker study. The focus will be on resolving any remaining questions about the location of populations of razorbacks in Lake Mead from the lower Grand Canyon (Separation Canyon) area downstream to Hoover Dam, documenting use and availability of spawning areas at various water elevations, clarifying substrate requirements, monitoring potential nursery areas, continuing ageing studies and confirming recruitment events that may be tied to physical conditions in the lake. The LCR MSCP and the U.S. Fish and Wildlife Service (USFWS) will agree to the term and further define the scope of this study. This study may be followed by further research and monitoring within the adaptive management program of the LCR MSCP.
2. Reclamation will to the maximum extent practicable provide rising spring (February–April) water surface elevations of 5–10 feet on Lake Mead, to the extent hydrologic conditions allow. This operation plan will be pursued through Beach/Habitat Building Flows (BHBF) and/or equalization and achieved through the Glen Canyon Adaptive Management Program and Reclamation's Annual Operating Plan processes, as determined for spawning razorback suckers.
3. Reclamation will continue existing operations on Lake Mohave that benefit native fish during the term of the LCR MSCP and will explore additional ways to provide benefits to native fish.
4. Reclamation will monitor water levels of Lake Mead from February through April of each year during the term of the LCR MSCP. The LCR MSCP will evaluate the impacts to razorback spawning at water levels below elevation 1160 feet mean sea level (msl). The ISC/SIA BO includes a conservation measure to collect and rear larval razorbacks from Lake Mead if the lake elevation falls below this level, based upon an assumption that razorback spawning would be reduced or eliminated at water elevations below that level. It should be noted however, that the spawning population of razorback sucker found in Echo Bay moved to a lower elevation in 2002 and spawned, as the spawning location they had previously used was dry. This indicates that razorback sucker can successfully move their spawning location into progressively lower elevations of the lake as the lake recedes. Given this new information, the LCR MSCP and USFWS will evaluate the data developed in measure number 1, and determine if larva collection is appropriate, and if so at what water elevation it should be implemented.

M.3 Discussion/Analysis—Background

Hydrologic modeling was performed to show the probability of future hydrologic conditions for Lake Mead. Since the future conditions are most sensitive to the inflows into the system, the model is run 85 times, each with a different inflow assumption based on historical data. The resulting set of possible outcomes (called "traces") is then statistically analyzed. These analyses consist primarily of ranking the outcomes in each future year and computing percentiles from the rankings. A complete description of the modeling procedure may be found in Appendix J.

M.4 Assumptions used in Modeling

The following assumptions were used for the modeling:

M.4.1 Covered Actions

1. ISC: current provisions are extended to 2051.
2. Transfers: 845,000 acre-feet per year (afy) is transferred from below Davis Dam to above Hoover Dam, 860,000 afy from below Parker Dam to above Davis Dam, and 1.174 million acre-feet per year (mafy) from Imperial Dam diversions to above Parker Dam.[1]
3. Shortage Criteria: The first level shortage is triggered by elevations that protect Mead elevation 1050 feet msl with approximately 80 percent assurance (80P1050). The second level shortage protects Lake Mead elevation 950 feet msl with 100 percent assurance. These levels represent the lowest levels Reclamation may use for shortage criteria when established, in order to provide the lowest extreme for impact analysis. The 600,000 af of water conserved through federal conservation efforts does not stay in Lake Mead and isn't distributed downstream. This provides the worst case scenario for impacts to Lake Mead. This assumption is used because while the 600,000 af will be distributed downstream, at this time routing and destination of this water is unknown. This scenario also covers any impacts a maximum reduction of 60,000 af from Virgin and Muddy River inflows due to development of that water by Nevada. That amount of water is subsumed in the 600,000 af discussed above. Also, some portion of the conserved water may stay in Lake Mead over some period of time.
4. 1944 Water Treaty Deliveries: 1.515 maf of water delivered annually to Mexico. Up to 200,000 af in surplus water is made available to Mexico during flood control surplus events. Flows in excess of 1.7 maf are possible and are the result of flood control releases required by U.S. Army Corps of Engineers (Corps) regulations applicable to operation of Hoover Dam.

M.4.2 Baseline

1. ISC: terminate in 2016.
2. Transfers: 400,000 af is transferred from Imperial Dam diversions to above Parker Dam.
3. Shortage Criteria: The first level shortage is triggered by elevations that protect Mead elevation 1083 feet msl with approximately 80 percent assurance (80P1083). The second level shortage protects Lake Mead elevation 1000 feet msl with 100 percent assurance. There are no shortage criteria at present for Lake Mead operations. The criteria used for the baseline are based on operations staff judgment

[1] Note: Reclamation has consulted on and received environmental compliance under the ISC/SIA BO for transfer of 400,000 af.

of a probable scenario for protection. This criteria has been used in previous analyses, and is used here for consistency.

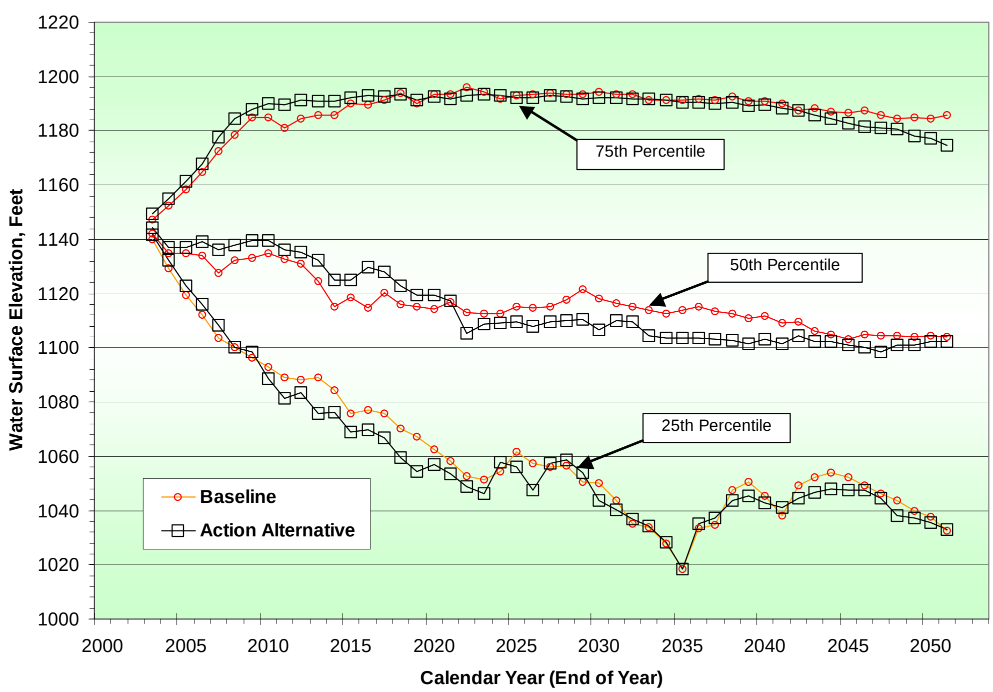
4. 1944 Water Treaty Deliveries: 1.515 maf of water delivered annually to Mexico. Up to 200,000 af in surplus water is made available to Mexico during flood control surplus events. Flows in excess of 1.7 maf are possible and are the result of flood control releases required by Corps regulations applicable to operation of Hoover Dam.

M.5 Modeling Results

M.5.1 Analysis with Three Covered Actions

The results of the analysis of the covered actions are as follows: Figure M-1 shows the 75th, 50th (median), and 25th percentile levels for Lake Mead elevations for the baseline and covered actions for the years 2002 through 2051. These percentile levels were selected for analysis because higher and lower levels (the 90 percent and 10 percent, as were used in previous analyses) reflected least likely scenarios. The 90 percent level represents essentially maximum inflow to Lake Mead over the period of analysis, and the 10 percent level represents continual drought conditions over the period of analysis.

Figure M-1
Lake Mead End-of-December Water Elevations
Comparison of Baseline to Action Alternative (All Actions)
75th, 50th, and 25th Percentile Values



It should be noted that none of these lines are the result of any particular assumed inflow (or outcome), but rather are a statistical compilation of the set of possible outcomes. Therefore, they are used to show general trends over the next few decades. The general decline in lake level at the 25th and 50th percentile levels for both the baseline and covered actions is a result of future Upper Basin depletions.

At the 50th percentile, under the baseline, Lake Mead is predicted to decline from approximately 1,142 feet in December 2003 to approximately 1,104 feet in December 2051. As stated before, decline is due to future Upper Basin depletions.

At the 50th percentile under the covered actions, the same trend is noted, Lake Mead will decline 38 feet from approximately 1142 feet msl in December 2003 to approximately 1,104 feet msl in December 2051. During the intervening years, Lake Mead will be somewhat higher under the covered actions from 2002 through 2021 (maximum difference 15 feet higher in 2016). After 2020, Lake Mead would be slightly lower under the covered actions (maximum difference approximately 12 feet lower in December 2030).

To further understand the potential effects of extending the ISC, 75th percentile and 25th percentile scenarios were also analyzed. At the 75thth percentile Lake Mead gradually rises from approximately 1147 feet msl to 1193 feet msl by 2018 and ends the sample period in 2051 at approximately 1186 feet msl. The maximum difference in elevation between the baseline and covered actions is 11 feet occurring at the end of the study period.

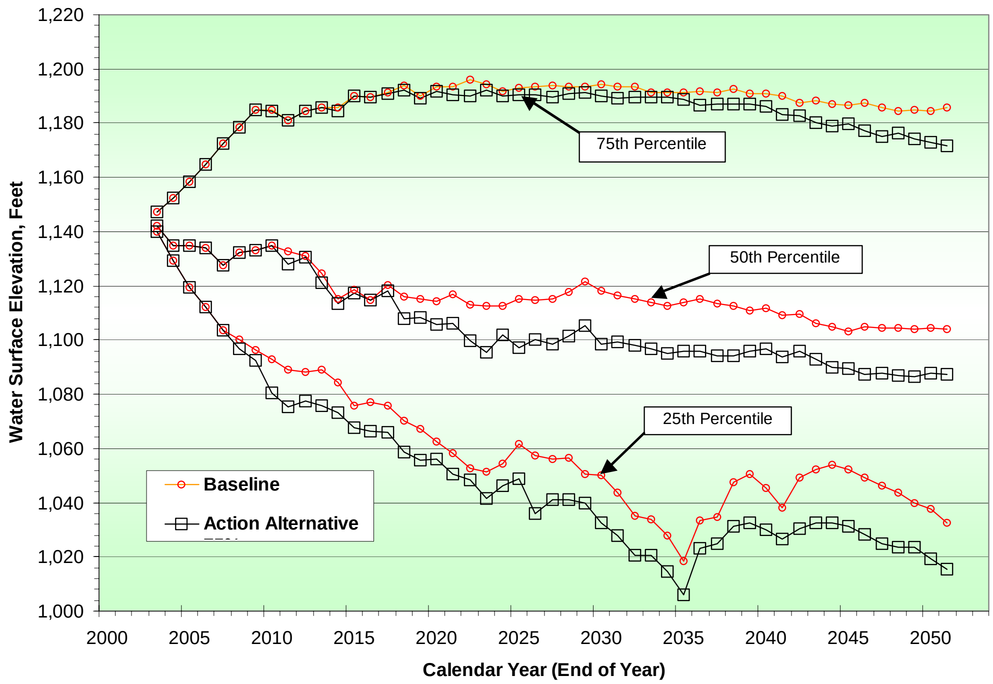
At the 25th percentile the baseline indicates lake levels would decline to approximately 1,018 feet in 2035 and then generally rise to 1032 feet msl at the end of the study period in 2051. The covered actions indicate lake levels to follow the same trend and end at 1033 feet msl, approximately 1 foot higher.

M.5.2 Analysis with Individual Actions

An analysis of the proposed alternative was conducted as well as an analysis to determine the effect of each of the three separate actions that comprise the proposed alternative. This included the effect of the transfers, effect of the lower shortage protection and the effect of extending the interim surplus criteria. An additional analysis of the effect of extending the surplus criteria plus the lower shortage criteria was also conducted.

The effect of the transfers alone would have a positive effect on Lake Mead elevations in that there is a probability of higher Lake Mead levels than the baseline levels that may occur over the program term. This is a result of more water being made available for municipal and industrial purposes from agricultural use, not from surplus determinations out of Lake Mead. The individual effect of the lower shortage protection and extending the surplus criteria (“no transfers option”) show probability of lower Lake Mead levels as opposed to the baseline (Figure M-2). The effect of the no transfers option shows differences from the proposed alternative. The first difference between the proposed alternative and the no transfers option occurs before 2017, which indicates little differences between the no transfers option from the baseline. After 2017, comparison shows a larger difference at the 50th percentile level than the proposed alternative. The no transfers option shows a maximum 20 feet lower elevation than the baseline. These analyses are further described in Appendix J.

Figure M-2
Lake Mead End-of-December Water Elevations
Comparison of Baseline to Action Alternative Number 1D Conditions
(Action Alternative Number 1D—Includes Extension of the
Interim Surplus Guidelines and Lower Shortage Criteria)
75th, 50th, and 25th Percentile Values



Several factors may influence the potential impacts of the implementation of the covered actions. The modeling suggests Lake Mead water surface elevation will fluctuate between full and progressively lower levels. Neither the timing of water level variations between the highs and the lows, nor the length of time the water level would remain high nor low can be predicted. These events would depend on the future variation in basin runoff conditions. However, the timing of the decline, as it relates to the exposed sediment, will influence the future riparian habitat composition. The amount of decline may influence the establishment of riparian habitat. Also, the potential for re-filling Lake Mead must be considered.

M.5.3 Impact on Delta at Lake Mead

The first factor is the timing of lake level declines. From January 1978 until June 1990, Lake Mead elevations were above 1,182 feet on a continuous basis. In June, 1990, Lake Mead elevation declined to approximately 1,182 feet and stayed below that elevation until the end of 1992. The initial decline to 1,182 feet in June, 1990, and 1,179 feet in July, 1990, coincided with seedfall for Goodding willow. Approximately 1,400 acres of predominantly Goodding willow became established at the Lake Mead delta, near Pierce Ferry, Arizona, as sediments became exposed during this time period. Willow stands also became established along the lower Grand Canyon, below Separation Rapids to the Lake Mead delta, and at the mouths of the Virgin and Muddy Rivers. In contrast, Lake Mead elevations were rarely above 1,182 feet prior to 1978, with an eleven month period from May, 1962, until March, 1963, representing the longest period that Lake Mead elevation stayed above that mark, inundating the delta area. Drought conditions in the 1950s, compounded by the filling of Lake Powell in the 1960s, produced a scenario where Lake Mead elevations exposed the delta area for periods as long as ten years. During the years when Lake Mead elevations were high enough to inundate the delta, these high lake levels almost always occurred during June and July. The Lake Mead delta only became exposed before or after cottonwood-willow seedfall. Thus, saltcedar, which seeds from early spring to late fall, became the predominant community type in the Lake Mead delta area (Bureau of Reclamation unpublished data).

As Lake Mead elevation declines, sediments become exposed. A second factor that may influence the type of plant community that will become established is the depth to groundwater or river surface elevation from these exposed sediments. Current lake bottom elevations are not known and may, in fact, be slightly higher than the 1,182 foot elevation seen in 1990 due to the Glen Canyon experimental beach/habitat-building flow conducted during the spring of 1996 and normal sedimentation since then. As the lake level declines and the present day lake bottom becomes exposed, the river elevation as it downcuts through the newly exposed delta will help determine whether cottonwoods or willows can survive, even if they become established. If the river surface elevation is 8–10 feet below the surface of the exposed soil, cottonwoods and willows would begin to incur mortality, thus, opening gaps for saltcedar and other species to become established.

The hydrologic modeling shows that Lake Mead elevations are projected to fluctuate between full level and progressively lower levels during the period of analysis (2003–2051) under both the baseline and covered actions. However, as wet hydrologic cycles occur in the future, Lake Mead will fill. If this event occurs after the establishment of riparian habitat due to declining lake levels, the newly established habitat would become inundated as occurred in the mid-1990s.

It is difficult to determine exactly how many acres of riparian habitat may be formed due to declining Lake Mead elevations. The majority of the Lake Mead shoreline does not have the soil necessary to regenerate riparian habitat. Riparian habitat created by declining lake levels would most likely occur in four areas: Lake Mead delta, Virgin River delta, Muddy River delta, and the portion of the Grand Canyon influenced by Lake Mead.

M.5.4 Impact on Razorback Sucker Spawning Habitat

The spawning habitat for razorback sucker in Lake Mead may be affected under both the No Action and covered actions. The known spawning elevations for the razorback sucker that may be important occur between 1120 and 1150 feet msl in Lake Mead. These elevations would be protected 50 percent of the time under both the baseline and the covered actions until 2013. Lake elevations are below the entire known spawning location at the 25th percentile by 2005. A complete discussion of the spawning locations and effects of lowering water levels on those locations and nursery habitats is found in the ISC/SIA BO. New information shows, however, the spawning population of razorback sucker found in Echo Bay moved to a lower lake elevation in 2002 and spawned, because the spawning location they had previously used was dry (Welker and Holden 2004). This indicates the razorback sucker can successfully move their spawning location into progressively lower elevations in the lake as the lake recedes. Sediment accumulation over available spawning substrate in Las Vegas Bay has been raised as an issue. A recent study of the lake bottom in the Las Vegas Bay indicates, however, that accumulated sediment is probably not an issue except where sediment comes in from Las Vegas Wash. The study revealed that sediment accumulation on the lake bottom outside of the old river channel was very thin and that alluvial deposits and rock outcrops are still exposed on large parts of the lake floor (Twichell and Rudin 1999).

M.6 Conclusion

As shown by the above analysis, there are only minimal differences at the 25th, 50th and 75th percentile levels on Lake Mead elevations for the covered actions and the No Action Alternative. The worse case analysis (no transfers option) shows larger differences.

The actual impacts to Lake Mead levels that may occur will likely fall somewhere between the levels that are shown for all three covered actions and those shown for the no transfers option. This is due to uncertainty whether the full amount of the proposed transfers (1.174 mafy between Imperial Dam and Parker Dam, and 0.845 mafy between Parker Dam and Hoover Dam) would actually occur during the life of the project.

Based on that analysis, terrestrial habitat and razorback sucker spawning habitat associated with Lake Mead habitats may be affected as a result of implementing the covered activities. Due to the uncertainty of how much of the transfers will actually occur the extent of the effect to those habitats cannot be determined.

M.7 References

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Twichell, D.C. and M.J. Rudin. *Surficial Geology and Distribution of Post-Impoundment Sediment of the Western Part of Lake Mead Based on a Sidescan Sonar and High-Resolution Seismic-Reflection Survey*. Based on U.S. Geological Survey Open-File Report 99-581. Available: <http://pubs.usgs.gov/of/of99-581/>. Accessed: August 14, 2003.

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